CLASSIFICATION SECRET

CENTRAL INTELLIGENCE AGENCY

INFORMATION REPORT

REPORT [redacted]

50X1-HUM

COUNTRY	USSR
SUBJECT	Ship Engines with Piston Gas Generators
PLACE ACQUIRED	[redacted]
DATE ACQUIRED	[redacted]
DATE OF INFORMATION	[redacted]
DATE DISTR.	24 Sep 1954
NO. OF PAGES	4
NO. OF ENCLS. (LISTED BELOW)	
SUPPLEMENT TO REPORT NO.	

50X1-HUM

THIS IS UNEVALUATED INFORMATION

50X1-HUM

[redacted]

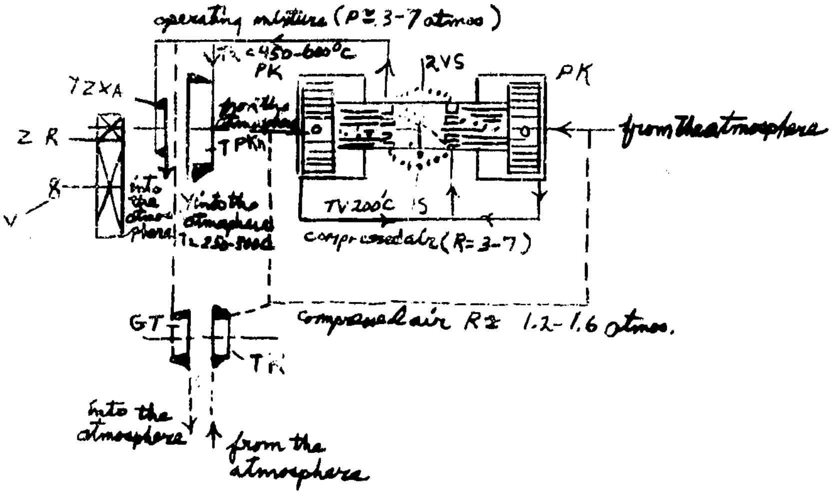
4. The power plant operates in the following manner: During the operating piston stroke of the engine, the air is brought into a single-stage simple action piston compressor (PK) and compressed up to 3-7 kg per sq cm after which it is directed into the operating cylinder of the engine where it effects the processes of exhaust, charging and supercharging of the cylinder. The mixture of the products of combustion and compressed air (or the gas-air mixture) having a pressure of 3-7 kg per sq cm and a temperature of about 450-600 degrees centigrade enters a nozzle apparatus leading into a separately installed constant pressure gas turbine (or a piston-type engine) thus setting the screw into motion. In the simplest case the air enters the compressor directly from the surrounding atmosphere. However, it is also expedient to put the air into the compressor under some pressure - Pk = 1.2-1.6 kg per sq cm (Pk- pressure before entering the compressor) from an auxilliary turbo compressor (TK) which is put into motion by a gas turbine (GT) as is shown by dots in the plan.

CLASSIFICATION SECRET

							DISTRIBUTION							
									[redacted]		ORR EV			

50X1-HUM

5. In this case the compressor works under supercharging and it is possible to raise the pressure of the gas-air mixture before it enters the turbine.



DVS -- Internal combustion engine

PK -- Piston compressor

TPKh- Forward motion turbine

TZKh- Reverse motion turbine

ZR -- Gear reducer

V - - Screw propellor

GT - Gas turbine

TK - Turbocompressor

TV - Temperature of the air going into the engine from the compressor

T - Temperature of the processed gases

T_2 - Temperature of the working mixture before entry into the turbine

The power balance of the gas generator (for the given plan) will equal: $N_i^D = 2N_i^K + N_{MECH}^{PGG} = \frac{2N_i^K}{\eta_M^{PGG}}$ or $2N_i^K = N_i^D \eta_M^{PGG}$ where N_i^D and N_i^K = Indicated power of the engine and compressor and N_{MECH}^{PGG} and η_M^{PGG} = indicated operation of friction and mechanical coefficient of useful action of the entire aggregate (PGG).

6. It is obvious from the equalization of the power balance that in order to receive a greater indicated operation of the aggregate it is desirable to be able to have a high mechanical coefficient of useful action of the gas generator (about 0.85-0.90).

The general coefficient of useful action of the power plant is: $\eta_{general} = \frac{N_T}{N_i^D}\eta_e^D = \delta\eta_e^D$ where N_T = power of the turbine N_i^D = indicated engine power η_e^D = effective coefficient of useful action of the engine $\delta = \frac{N_T}{N_i^D}$ = relative power of the gas turbine.

7. Comparison shows that power plants having piston gas generators have an effective coefficient of useful action that is about twice as high as that of plants operating on an open cycle with one-step compression and combustion, the coefficient of the former being $\eta_{general}$ = 35-40% and the coefficient of the latter being η_{GT} = 18-20%.

8. This difference is explained by the fact that in power plants having gas turbines a great part of the power of the turbine is used on the operation of the turbo-compressor N_K and consequently the effective power of the power plant N_e of the plant is the difference between the power of the gas turbine and the power of the compressor. N_e of the plant $= N_T - N_K$. Then, as in the power plant having a piston gas generator, the power plant power may equal or even be greater than the indicated power of the engine (if $\delta_T > 1$) N_e of the plant $= N_T = \delta_T N_i \vartheta$.

9. In gas turbines the products of combustion have to be cooled artificially from 1200-1600° C to 500-600° C before entering the turbine. This is accomplished at the expense of a considerable surplus of air for combustion (4-7 multiple [sic]) produced by the turbocompressor.

10. In the engine the cooling of the gases takes place at the expense of the polytropical expansion throughout the cylinder at the same time that the pistons are accomplishing useful action the compression of air in the compressors.

11. The marine free piston gas generator of the type 6 SPGG - $\frac{34.0}{2X44.3}$ has the rated power on the turbine shaft of $N_T = 1360$ hp. The diameter of the engine cylinder is D = 340 mm, the diameter of the compressors is Dk = 900 mm, the average piston stroke is S = 2x443 mm and the number of strokes (cycles) is PTsL = 613 per min. The special features of this aggregate are: The mechanism that synchronizes the piston operation, the presence of six nozzles for the combustion chamber two of which spray fuel into the antechambers and the oil cooling of the pistons.

12. The generator is regulated by changing the quantity and pressure of gas entering the turbine (which is done by varying the amount of fuel fed into the engine).

13. Results of experiments made on the aggregate show that at the rated power of 1360 hp with an operating pressure of PK = 3.4 KG per CM², and a productivity of Q G = 3.65 KG per second.

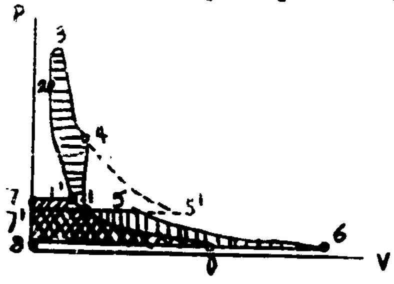
(a) The specific fuel consumption (on the turbine shaft) is ge = 154 grams per one effective horse power per hour, corresponding to the effective coefficient of useful action $\eta_e = 4\ldots\%$ with the coefficient of useful action of the turbine equalling 85%.

(b) Loss in cooling water is about 19-20%.

(c) Loss due to friction is about 9-10%.

(d) The temperature of gases before entering the turbine is about 510°C.

14. The operating cycle of the gas generator differs from that of the conventional engine in many particulars. By looking at the indicated diagram of the practicable process of the gas generator one can see that the area 1234 which represents the operation of the engine is equal to area 01'78 which represents the operation of the compressor. The operation, represented by area 145 is lost operation. The work of expansion in the gas turbine begins not at point 5' but at point 5 on account of the intermingling of the gases from the engine with the exhaust air which leads to a decrease in the specific mass of the mixture. The operation of the gas turbine (5687') can be more less or equal to the operation of the engine, depending on the amount of parameters of the gas-air mixture.



15. It has been determined that the thermal coefficient of useful action of the operating cycle of a power plant consisting of a compressor, an engine and a gas turbine and working on gases, equals the thermal coefficient of useful action of the engine operating cycle, but the degree of compression equals the general degree of compression of the engine (E) and the compressor (Ek) E general = Ek·E

16. The computation of the operating cycle of the gas generator may be accomplished by the usual method in part of the engine but with several additions and remarks.

[redacted] 50X1-HUM

17. The greatest supercharge pressure P_k in application of the single-step simple action compressor is determined by the greatest temperature admissible at the end of compression $T_b = 550°$ in absolute units (the self-igniting temperature of oil) and is not more than 4-6 kg per sq cm.

18. The least degree of compression is selected from the condition of the desired self-ignition of fuel - T_c 700° in absolute units (Kelvin) which leads to the degrees of compression of the order 4.5-6. The lower meanings of the degree of compression E, which are not usual for the engine are explained by the fact that the latter is the second step of air compression (after the compressor).

19. It has been determined that the high pressure of compression P_c and combustion P_z in this case are not dangerous for the engine since the engine does not transmit such increases of pressure in the cylinder.

20. It is considered expedient to proceed from the high meanings $P_c = 40 \div 80$ kg per sq cm and $P_z = 60 \div 120$ kg per sq cm which provides good conditions for the flowing of the process of fuel combustion.

21. It is considered expedient to use power plants having piston gas generators aboard ships when the power plant has a high horsepower (more than 5000-10,000 effective hp) or under conditions of extremely limited space and weight in the engine section of the ship.

22. In order to obtain a large amount of power, a series of identical piston gas generators can be used inasmuch as they are not connected directly to the screw.

23. The power plant can be regulated by changing the parameters of the air-gas mixture before the turbine or by regulating the amount of gas by changing the productivity of the generator gas or by turning off the generators. When a power plant consists of a large number of gas generators, if the generators are turned off in succession while the power plant is operating, the operating period of the power plant can be lenghtened and light and high speed-type generators can be used.

24. The use of power plants having piston gas generators in merchant shipping in the USSR was, until 1952, strictly of an experimental nature. As far as can be ascertained from the data published in the departmental press of the merchant and river fleets power plants of this type are still not widely used. 50X1-HUM

25. [redacted]

- end -

[redacted] 50X1-HUM